Alcohols & Carboxylic Acids

Question Paper 1

Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Organic Chemistry
Sub-Topic	Alcohols & Carboxylic Acids
Paper	(Extended) Theory
Booklet	Question Paper 1

TimeAllowed **87 minutes**

: Score: **/72**

Percentage: **/100**

1 The alcohols form an homologous series.

(a) Give **three** characteristics of an homologous series.

.....

.....

.....

..... [3]

(b) The following two alcohols are members of an homologous series and they are isomers.

$CH_3 — CH_2 — CH_2 — CH_2 — OH$ and $(CH_3)_2CH — CH_2 — OH$

(i) Explain why they are isomers.

.....

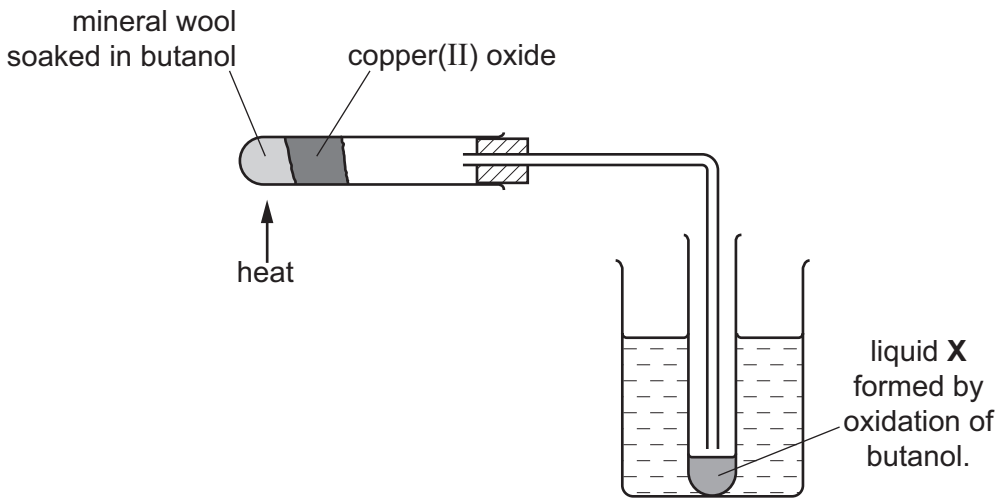
.....

..... [2]

(ii) Deduce the structural formula of another alcohol which is also an isomer of these alcohols.

[1]

(c) Copper(II) oxide can oxidise butanol to liquid **X**, whose pH is 4.



(i) Give the name of another reagent which can oxidise butanol.

.....

[1]

(ii) Which homologous series does liquid **X** belong to?

.....

[1]

(iii) State the formula of liquid **X**.

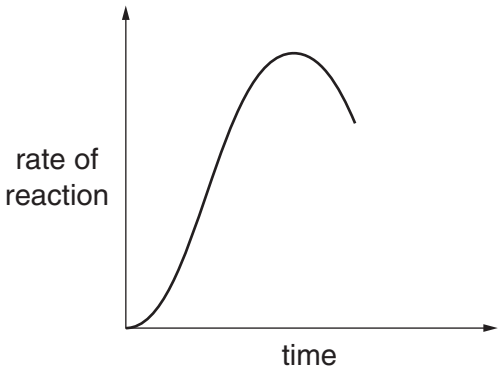
.....

[1]

(d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

Carbon dioxide is given off and the mixture becomes warm, as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.



(i) Suggest a method of measuring the rate of this reaction.

.....

..... [2]

(ii) Why does the rate initially increase?

.....

..... [1]

(iii) Suggest **two** reasons why the rate eventually decreases.

.....

..... [2]

[Total: 14]

2 The alcohols form a homologous series.

(a) Give **three** characteristics which all members of a homologous series share.

.....

.....

.....

..... [3]

(ii) Give the name of the third member of this series.

name ..... [1]

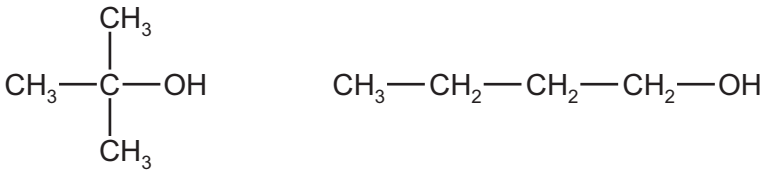
(iii) Deduce the molecular formula of the alcohol whose M_r = 158. Show your working.

.....

.....

..... [2]

(b) Explain why the following two alcohols are isomers.



.....

..... [2]

(c) This question is based on typical reactions of butan-1-ol.

(i) When butan-1-ol, $CH_3–CH_2–CH_2–CH_2–OH$, is passed over the catalyst silicon(IV) oxide, water is lost.

Deduce the name and the structural formula of the organic product in this reaction.

name .....

structural formula

[2]

(ii) Suggest the name of the ester formed from butanol and ethanoic acid.

..... [1]

(iii) Butan-1-ol is oxidised by acidified potassium manganate(VII).

Deduce the name and the structural formula of the organic product in this reaction.

name .....

structural formula

[2]

[Total: 13]

3 Alcohols can be made by fermentation or from petroleum.

(a) Ethanol can be made by the fermentation of glucose.

$$C_6H_{12}O_6(aq) \xrightarrow{\text{yeast}} 2C_2H_5OH(aq) + 2CO_2(g) \quad \text{exothermic reaction}$$

Yeast are living single-cell fungi which ferment glucose by anaerobic respiration. This reaction is catalysed by enzymes from the yeast.

(i) What is meant by the term *respiration*?

.....

.....

..... [3]

(ii) *Anaerobic* means in the absence of oxygen.

Name the products formed from respiration in the **presence** of oxygen.

..... [1]

(iii) What are enzymes?

..... [1]

(iv) Suggest a method of measuring the rate of this reaction.

.....

..... [1]

(b) The following observations were noted.

- When a small amount of yeast was added to the aqueous glucose the reaction started and the solution went slightly cloudy.
- The reaction rate increased and the solution became cloudier and warmer.
- After a while, the reaction rate decreased and eventually stopped, leaving a 14% solution of ethanol in water.

(i) Why did the reaction rate increase?

..... [1]

(ii) Suggest an explanation for the increase in cloudiness of the solution.

..... [1]

(iii) Give **two** reasons why the fermentation stopped.

.....

..... [2]

(c) One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

..... [2]

(d) Alcohols can be made from petroleum by the following sequence of reactions.

alkanes from petroleum $\rightarrow$ alkene $\rightarrow$ alcohol

Describe the manufacture of ethanol from hexane, C_6H_{14}. Include in your description an equation and type of reaction for each step.

.....

.....

.....

..... [5]

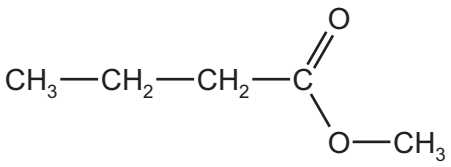
[Total: 17]

4 Esters, polyesters and fats all contain the ester linkage.

(a) Esters can be made from alcohols and carboxylic acids. For example, the ester ethyl ethanoate can be made by the following reaction.

$$CH_3COOH + CH_3CH_2OH \rightarrow CH_3COOCH_2CH_3 + H_2O$$

(i) Name the carboxylic acid and the alcohol from which the following ester could be made.



name of carboxylic acid .....

name of alcohol .....

[2]

(ii) 6.0 g of ethanoic acid, M_r = 60, was reacted with 5.5 g of ethanol, M_r = 46.
Determine which is the limiting reagent and the maximum yield of ethyl ethanoate, M_r = 88.

number of moles of ethanoic acid = ... [1]

number of moles of ethanol = ... [1]

the limiting reagent is ..... [1]

number of moles of ethyl ethanoate formed = ... [1]

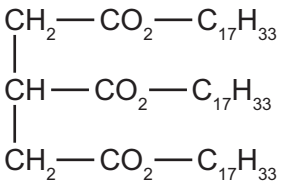
maximum yield of ethyl ethanoate = ... [1]

(b) The following two monomers can form a polyester.

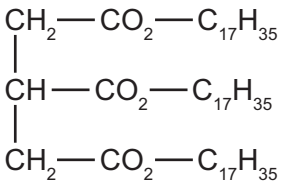
Draw the structural formula of this polyester. Include two ester linkages.

[3]

(c) Fats and vegetable oils are esters. The formulae of two examples of natural esters are given below.



ester 1



ester 2

(i) One ester is saturated, the other is unsaturated.
Describe a test to distinguish between them.

test .....

result with unsaturated ester .....

.....

result with saturated ester .....

.....

[3]

(ii) Deduce which one of the above esters is unsaturated. Give a reason for your choice.

.....

.....

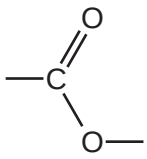
..... [2]

(iii) Both esters are hydrolysed by boiling with aqueous sodium hydroxide.
What types of compound are formed?

..... and ..... [2]

[Total: 17]

5 The ester linkage showing all the bonds is drawn as



or more simply it can be written as –COO–.

(a) (i) Give the structural formula of the ester ethyl ethanoate.

[1]

(ii) Deduce the name of the ester formed from methanoic acid and butanol.

..... [1]

(b) (i) Which group of naturally occurring compounds contains the ester linkage?

..... [1]

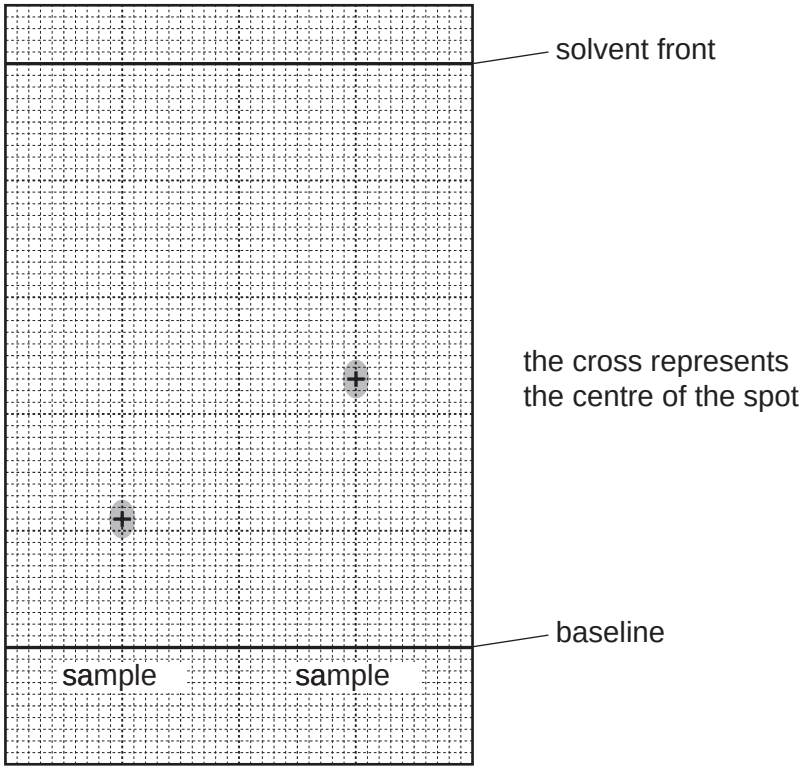
(ii) Draw the structural formula of the polyester formed from the following monomers.

$HOOCC_6H_4COOH$ and $HOCH_2CH_2OH$

You are advised to use the simpler form of the ester linkage.

[3]

(c) Esters can be used as solvents in chromatography. The following shows a chromatogram of plant acids.



An ester was used as the solvent and the chromatogram was sprayed with bromothymol blue.

(i) Suggest why it was necessary to spray the chromatogram.

.....

..... [2]

(ii) Explain what is meant by the R_f value of a sample.

.....

..... [1]

(iii) Calculate the R_f values of the two samples and use the data in the table to identify the plant acids.

plant acid	R_f value
tartaric acid	0.22
citric acid	0.30
oxalic acid	0.36
malic acid	0.46
succinic acid	0.60

sample 1 R_f = ... It is ..... acid.

sample 2 R_f = ... It is ..... acid. [2]

[Total: 11]